



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
|-----------------|-------------|----------------------|---------------------|------------------|

09/975,466

10/09/2001

Auguste J.L. Sophie

ASMMC.036AUS

8303

20995

7590

03/28/2003

KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

EXAMINER

KIELIN, ERIK J

ART UNIT

PAPER NUMBER

2813

DATE MAILED: 03/28/2003

12

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/975,466

Applicant(s)

SOPHIE ET AL.

Examiner

Erik Kielin

Art Unit

2813

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 14 January 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-17, 28 and 30-32 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-17, 28 and 30-32 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other: _____

DETAILED ACTION

This action responds to the Amendment (Paper No. 9), the corrected drawings (Paper No. 10) and the IDS (Paper No. 11) each filed on 14 January 2003.

Information Disclosure Statement

1. The information disclosure statement filed 29 January 2002 fails to comply with the provisions of 37 CFR 1.97, 1.98 and MPEP § 609 because some of the references have not been provided with dates in accordance with 37 CFR 1.98(b)(5). Also the MPEP 609 states,

“Each publication must be identified by publisher, author (if any), title, relevant pages of the publication, and **date** and place of publication. The date of publication supplied must include at least the **month and year** of publication, except that **the year of publication (without the month) will be accepted if the applicant points out in the information disclosure statement that the year of publication is sufficiently earlier than the effective U.S. filing date and any foreign priority date so that the particular month of publication is not in issue.**” (Emphasis added.)

The IDS has been placed in the application file, but only the references initialed by Examiner have been considered. Applicant is advised that the date of any re-submission of any item of information contained in this information disclosure statement or the submission of any missing element(s) will be the date of submission for purposes of determining compliance with the requirements based on the time of filing the statement, including all certification requirements for statements under 37 CFR 1.97(e). See MPEP § 609 ¶ C(1).

2. The information disclosure statement filed 29 January 2002 fails to comply with 37 CFR 1.98(a)(3) because it does not include a concise explanation of the relevance, as it is presently understood by the individual designated in 37 CFR 1.56(c) most knowledgeable about the

Art Unit: 2813

content of the information, of each patent listed that is not in the English language. The patent DE 41 08 73 is totally in German and has not been considered.

This is repeated from the action filed 15 October 2002. While Examiner acknowledges Applicant statement in the Amendment filed 14 January 2003 (Paper No. 9), at p. 3, that the "Examiner is requested to assume that these reference publications predate the filing date of the present application by more than one year," this is not a clear statement on the record that the month of publication is not an issue. Moreover, Applicant did not address the reference DE 41 08 73, totally in German, which was also not considered.

Drawings

3. The corrected or substitute drawings were received on 14 January 2003. These drawings are approved.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

5. Claims 1-17 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Amended claim 1 adds the limitation that the organic reducing agent is "stable." This is not supported by the specification. Given that the organic reducing agent is used to reduce

Art Unit: 2813

copper oxide to copper metal at temperatures as low as room temperature, the organic reducing agent is clearly not stable. Rather the organic reducing agent is quite unstable because it reacts with copper oxide at room temperatures. Moreover, there exists no antecedent basis in the specification for the new limitation.

The remaining claims are rejected for depending from the above rejected claims.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claims 1, 3, and 8-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent Application 2002/0027286 A1 (**Sundararajan et al.**) in view of US 6,006,763 (**Mori et al.**).

Regarding claims 1 and 8, **Sundararajan** discloses a process for producing an integrated circuit comprising forming a copper damascene structure **140, 145** on a substrate (Fig. 1A); forming a copper oxide on the copper during CMP (as further limited by instant claim 8); reducing the copper oxide by contacting the oxide with "typically" hydrogen or ammonia plasma --which is a vapor-- (paragraphs [0008] and [0018]), prior to forming a layer comprising silicon carbide, SiC or SiCN (paragraph [0009] and) in the same chamber, wherein the reduction improves the surface for depositing the SiC or SiCN layer, and wherein the layer of SiC or SiCN serves as an etch stop **125** (Fig. 1B; paragraph [0022]).

Sundararajan does not teach that that reductive treatment employs contacting the copper oxide with a “stable” organic reducing agent.

Mori teaches an apparatus and method of using, to provide surface treatment of integrated circuits, in general, (col. 1, lines 12-20) wherein metal oxide is reduced to metal using a “stable” organic reducing agent vapor (paragraph bridging cols. 3-4). Exemplary organic reducing agents such as propane and decane are taught (col. 12, lines 5-34).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use an organic reducing agent to reduce the copper oxide of **Sundararajan** to copper, as taught by **Mori**, because **Sundararajan** is not limited to any specific method, and because one of ordinary skill would recognize, by the **Mori** teaching, that metal oxides can be reduced to metals using organic reducing agents.

Regarding claim 3, an etch stop layer is a hard mask by definition. Even so, it has been held that to be entitled to weight in method claims, the recited structure limitations therein must affect the method in a manipulative sense, and not amount to the mere claiming of a use of a particular structure. See *Ex parte Pfeiffer*, 1962, C.D. 408 (1961). In this case that the SiC layer serves as a stop layer is not manipulative of the method and therefore is not considered to have patentable weight. Moreover, because the materials are the same in the same damascene structure as shown in Applicant's figures, it is very clear that the SiC serves as a hardmask to every extent as indicated by Applicant.

Regarding claims 9, because the copper is necessarily exposed during CMP and cleaning, the oxide is formed by exposure to “a cleanroom atmosphere.”

Art Unit: 2813

Regarding claims 10-12 and 14-16, **Sundararajan** discloses the deposition necessarily takes place in a first chamber. The temperature therein is 300 to 450 °C. Further regarding claim 16, although the temperature of about 400 °C is not specifically indicated, the selection of the 400 °C is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. See *In re Jones*, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and *In re Boesch*, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious).

Regarding claim 13, that the second chamber is clustered to a first reaction chamber does not have patentable weight because it is not manipulative of the invention. See *Ex parte Pfeiffer*, as above. Nonetheless, cluster tools are known and it would be obvious to one of ordinary skill in the art to use a cluster tool with separate chambers for the separate processes as in a cluster tool, to protect the copper layer from re-oxidation prior to the deposition of the SiC layer, in accordance with the objective in **Sundararajan**.

Regarding claim 17, **Sundararajan** does not disclose the temperature at which the copper is reduced. It would have been obvious for one of ordinary skill in the art, at the time of the invention to use the same temperature for reducing the copper oxide layer as that used for deposition in order to save time in changing the temperature, and because it would appear that the reduction temperature being equal to the deposition temperature would work just as well as some other temperature.

Art Unit: 2813

8. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Sundararajan** in view of **Mori** as applied to claim 1 above, and further in view of Applicant's admitted prior art (**APA**).

The prior art of **Sundararajan** in view of **Mori**, as explained above, discloses each of the claimed features except for indicating that the silicon carbide layer contains oxygen.

APA teaches that it is known to use SiC and SiOC as a barrier/etch stop layer. (See instant specification, p. 3, lines 8-10.)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use silicon carbide with oxygen, because the selection of a known material suitable for an intended purpose is *prima facie* obvious in the absence of unexpected results. Moreover, one of ordinary skill would be motivated to use SiOC because it has a lower dielectric constant than silicon nitride, thereby aiding in the reduction of RC delay which is highly desired in the art.

9. Claims 4-7, and **28**, 30, 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Sundararajan** in view of **Mori** and US 5,865,365 (**Nishikawa et al.**).

The prior art of **Sundararajan** in view of **Mori**, as explained above, discloses each of the claimed features of claims 1 and 28, except for indicating that the organic reducing agents are specifically aldehydes (instant claims 4, 6, and 28), alcohols (instant claims 4, 5, and 28), or carboxylic acids (instant claims 4, 7, and 28).

Nishikawa teaches the method and mechanism by which aldehydes, alcohols, and carboxylic acids reduce metal oxides to metal, for metallization in integrated circuits (col. 6, line 47 to col. 7, line 4; col. 7, Table 1.)

Art Unit: 2813

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use any of the claims alcohols, aldehydes, or carboxylic acids as the organic reducing agent in **Mori** to reduce the copper oxide of **Sundararajan** because **Mori** is not limited to any specific organic reducing agent, and one of ordinary skill would recognize that the reducing agents in **Nishikawa** would work just as well for reducing metal oxide to metal as those in **Mori**. Moreover, it has been held that the selection of a material suitable for an intended purpose is *prima facie* obvious in the absence of unexpected results. There exists no evidence of record that the organic reducing agents presently claimed perform any better than those in **Mori** or **Sundararajan**.

Regarding claims 30 and 32, as noted above, **Sundararajan**, discloses that the etch stop layer comprises silicon carbide SiC or silicon nitride as SiCN.

10. Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Sundararajan** in view of **Mori** and **Nishikawa**, as applied to claim 28 above, and further in view of Applicant's admitted prior art (APA).

The prior art of **Sundararajan** in view of **Mori** and **Nishikawa**, as explained above, discloses each of the claimed features except for indicating that the silicon carbide layer contains oxygen.

APA teaches that it is known to use SiC and SiOC as a barrier/etch stop layer. (See instant specification, p. 3, lines 8-10.)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use silicon carbide with oxygen, because the selection of a know material suitable for an

Art Unit: 2813

intended purpose is *prima facie* obvious in the absence of unexpected results. Moreover, one of ordinary skill would be motivated to use SiOC because it has a lower dielectric constant than silicon nitride, thereby aiding in the reduction of RC delay which is highly desired in the art.

Response to Arguments

11. Applicant's arguments filed 14 January 2003 (Paper No 9) have been fully considered but they are not persuasive.

Applicant argues on p. 4, that neither Sundararajan nor Mori teach the use of a "stable" organic reducing agent. Examiner respectfully disagrees. While Examiner acknowledges that Applicant is trying to distinguish between a an organic reducing agent activated by a plasma and a non-plasma-activated organic reducing agent, the term "stable" does not suffice for this purpose. The organic reducing agent used in Mori, while activated by a plasma, is still a "stable" organic molecule, in and of itself, to every extent as are the organic reducing agents indicated in the instant application and claims. Inasmuch as the organic reducing agents in Mori and in the instant application undergo chemical reactions to reduce copper oxide to copper metal, they are equally unstable --not stable. For if they were stable, then they would not undergo chemical reaction to reduce the copper oxide, contrary to the requirement in the claims. Moreover, inasmuch as Applicant's specification indicates that a plasma may be applied to the organic reducing agents, it is clear that the organic reducing agents are again stable to every extent as indicated in the specification.

Applicant argues on p. 5,

Art Unit: 2813

“Neither Sundararajan nor Mori teach or suggest that the organic reducing agent comprises at least one functional group selected from the group consisting of alcohol, aldehyde and carboxylic acid.”

“The Examiner cites Nishikawa (U.S. Patent No. 5,865,365) for teaching the use of aldehydes, alcohols and carboxylic acids to reduce metal oxides. Nishikawa teaches the use of organic material in the liquid state (see, for example, col. 4, lines 29-31 and col. 5, lines 15-16) and does not teach or suggest the use of vapor phase organic reducing agents. Thus Applicant’s submit that Nishikawa does not make up the deficiencies of Sundararajan and Mori.”

Examiner respectfully disagrees. Mori teaches the use of a vapor phase organic reducing agent and is not limited to the identity of the organic reducing agent. Nishikawa provides known organic reducing agents to reduce metal oxides to metal, which is the objective in each of Sundararajan, Mori, and Nishikawa. Accordingly, the use of the presently claimed type of organic reducing agent is simply material choice made obvious by Mori. That Nishikawa does not use a vapor phase in no way suggests that one of ordinary skill would not use the organic reducing agents of Nishikawa because Mori clearly teaches that organic liquids (e.g. decane, $C_{10}H_{22}$) are made vapors for the purpose of his invention. Thereby one of ordinary skill knows well that organic materials evaporate to form a vapor.

Moreover, no unexpected results have been provided relative to the exemplary organic reducing agents provided in Mori, and Mori uses the general terminology “organic substance” (Mori, col. 4, line 2) to describe the reducing agents, thereby indicating that other organic substances may be used.

Art Unit: 2813

Conclusion


12. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at 703-308-4940. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.


Erik Kielin
March 25, 2003